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An Investigation of Tree Biomass in the Great Smoky Mountains National Park

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Abstract

We determined the biomass (carbon storage) of four forest types in the Great Smoky Mountains National Park: pine/oak, cove hardwood, northern hardwood, and spruce/fir. Based on the GLOBE Programs land cover protocols (www.globe.gov), and the University of New Hampshire's GLOBE Carbon Cycle Program (http://globecarboncycle.unh.edu/), we knew that species and tree circumference would be the two most critical factors in determining biomass, but we also hypothesized that number of trees in a study site and the elevation of the site would impact biomass. We hypothesized that old growth forest would contain greater biomass than a young forest. We recorded tree species and circumference for every tree that had a circumference greater than 15 centimeters in each plot of 900 square. The circumference of a total of 219 trees represented by 22 different species, as well as forest type, elevation, and GPS coordinates for each plot, were recorded.

Hypotheses

Old growth forest will contain greater biomass than a young forest.

The number of trees in a study site and the elevation of the site will impact biomass.

Research questions

1. Which forest type will contain the most biomass in our study?

2. What factors will contribute to the greatest biomass?
   - The number of trees in the study site
   - Elevation of the study site
   - Circumference of the trees
   - Species of the tree

Study Sites

Plot 1 – Spruce/Fir	5760 feet elevation
Plot 2 – Northern Hardwood	4052 feet elevation
Plot 3 – Pine and Oak	2290 feet elevation
Plot 4 – Pine and Oak	2930 feet elevation
Plot 5 – Cove Hardwood*	3496 feet elevation

*Old Growth

Descriptive Summary of Each Plot

Plots	# of Trees	# of Different Species	Average Circumference	Standard Deviation	Total Above Ground Biomass	Total Above Ground Carbon Storage
1	95	6	40.969	26.899	9,302,742	4,651,371
2	23	6	69.974	77.240	15,846,261	7,923,130
3	76	11	56.780	35.997	19,493,557	9,746,778
4	12	7	88.000	55.992	6,521,043	3,260,521
5	13	5	119.746	84.171	21,469,292	10,734,646

Multiple Regression Model Summary Table Examining Factors Influencing Biomass

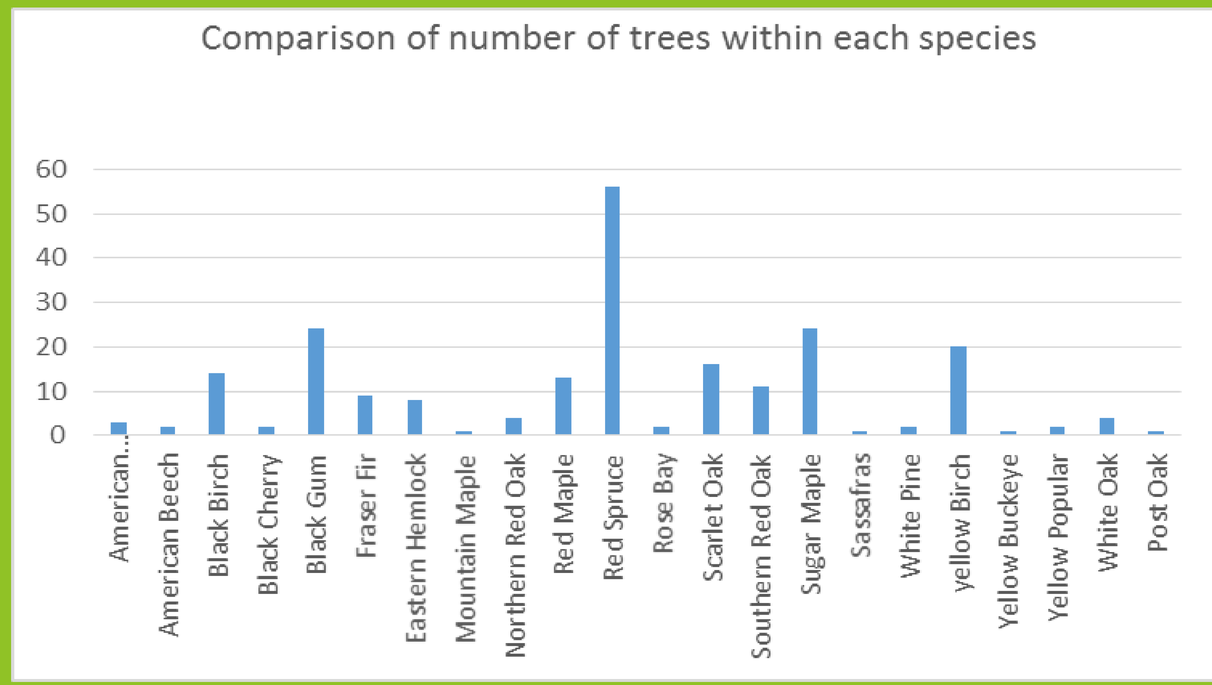
Model	Sum of Squares	Df	Mean Square	F	Significance	R^2
1.						
Regression	1.246 x 1014	4	3.116 x 1013	125.664	<.001	0.701
Residual	5.306 x 1013	214	2.479 x 1011			
Total	1.777 x 1014	218				

Model 1 - Plot, Circumference, Elevation, and Tree Species as the IV and Biomass as the DV

Coefficients Table Examining Variables Potentially Influencing Biomass Within a Study Plot

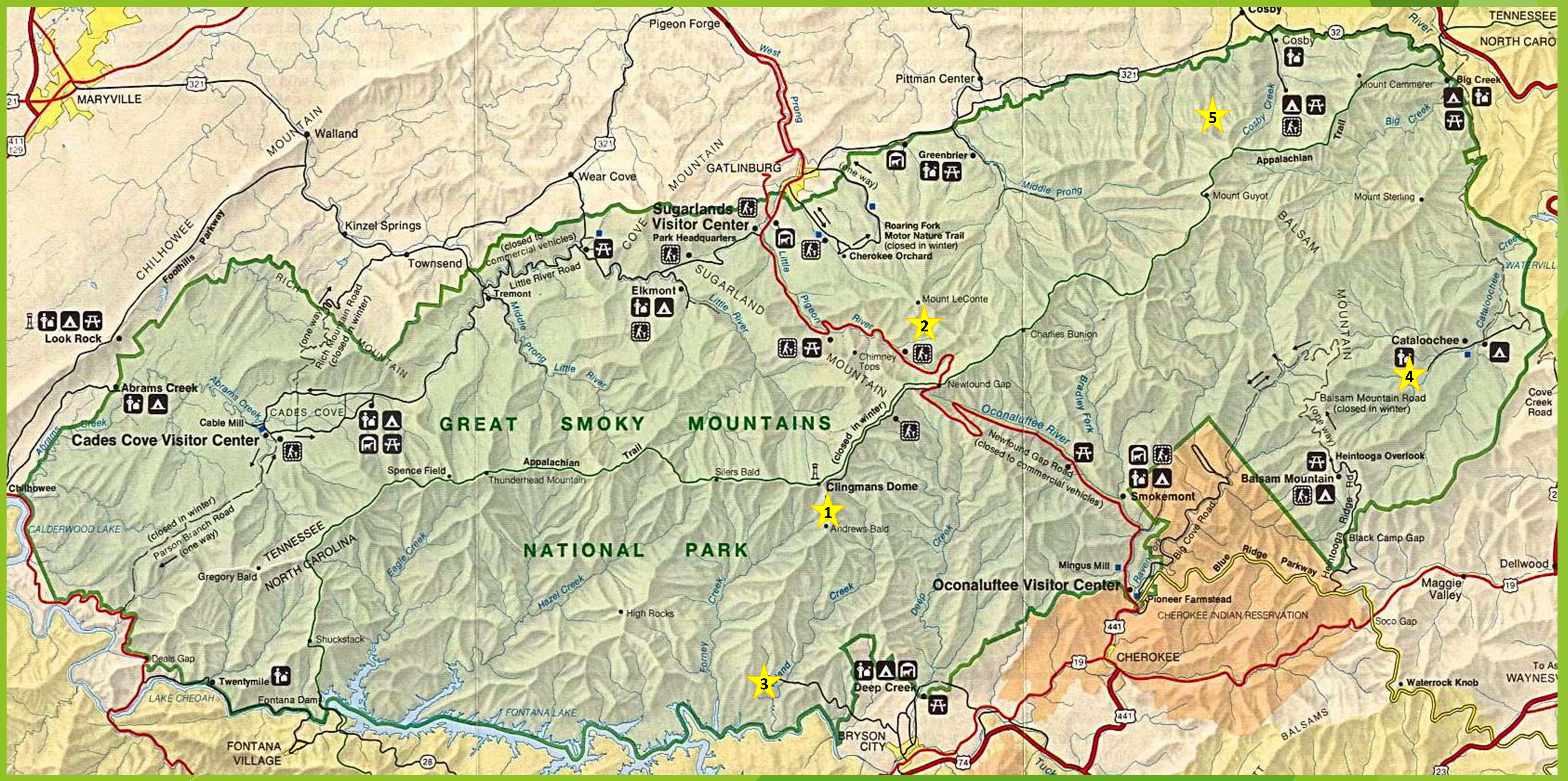
		Unstandardized Coefficients		Standardized Coefficients			
Model		B	Std. Error	Beta	t	Sig.	r^2
1	Constant	-1012932.044	278515.278		-3.637	<.001	
	Plot #	82989.650	53791.725	.113	1.543	.124	.013
	Circumference	15422.980	781.747	.824	19.729	<.001	.679
	Species	-3353.433	6568.984	-.020	-.510	.610	<.001
	Elevation	79.982	39.434	.138	2.028	.044	.019

Model 1 - Plot, Circumference, Elevation, and Tree Species as the IV and Biomass as the DV



Statistical Analysis

Using SPSS to analyze the data, tree circumference was found to be the factor that explained the greatest variability in biomass (t = 19.729, p = 0.001, r2 = 67.9). We also found that old growth forest contained more biomass than younger forests ($x_{\text{old growth biomass}}$ = 21,469,292, $x_{\text{younger forests biomass}}$ = 12,790,900).A multivariate regression analysis was performed to identify the variables which had the greatest influence on biomass. Independent variables tested included: the plots, circumference, number of trees within a plot, and elevation of the plot, with the dependent variable of biomass. The average tree circumference for all plots together was 56.756 cm (*x* = 56.756, *SD* = 48.223). This model was found to be statistically significant and was able to account for 70% of the biomass in our study sites ($F_{4, 214}$ = 125.664, *p* = <.001, R^2 = .701*)*. Based on our coefficients table, we found that circumference had the largest power in explaining variance in biomass when combined with the other independent variables tested for (*t* = 19.729, *p* = <.001, r^2 = .679*).* In this model, the actual species was not statistically significant for explaining biomass.



Conclusions

Based on the results of our data, we found that circumference of the tree and not its species, had the greatest impact on biomass. Other researchers have shown that species would have a significant impact. We believe our result was due to the disproportional number of species measured in our study plots. Some species contained 56 individuals while others had only 1. This would affect our homogeneity of variance. We also found that the old growth forest contained the greatest biomass of the five sites and was statistically different from the spruce/fir forest and pine and oak forests we measured.

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